COVID Vaccines Analysis

Title: Analyzing the Effectiveness and Impact of COVID-19 Vaccination Programs

Abstract: The global response to the COVID-19 pandemic has been characterized by the rapid development and distribution of vaccines. These vaccines have played a crucial role in controlling the spread of the virus, reducing severe cases, and ultimately saving lives. This comprehensive analysis focuses on COVID-19 vaccination programs, offering insights into their development, distribution, effectiveness, and broader societal implications.

- Vaccine Development to COVID-19 Vaccines, Vaccine Platforms (mRNA, Viral Vector, Protein Subunit) ,Mechanisms of Action ,Efficacy and Variants ,Safety Profiles and Adverse Events
- Vaccine Distribution - Global Distribution Challenges , Supply Chain Logistics ,Vaccine Hesitancy and Public Perception, Equity in Access, International Collaboration
- Effectiveness and Impact , Reduction in COVID-19 Cases , Impact on Hospitalizations and Mortality ,Long-term Public Health Implications , Emerging Variants and Vaccine Adaptation
- Societal and Economic Implications -Economic Recovery , Social Reintegration , Psychological and Mental Health Effects , Vaccine Passports and Privacy Concerns
- Lessons Learned and Future Outlook - Key Takeaways from COVID-19 Vaccination Programs , Preparedness for Future Pandemics, Ethical Considerations , Conclusion and Policy Recommendations

This analysis provides a comprehensive overview of the development, distribution, effectiveness, and societal impacts of COVID-19 vaccines, offering valuable insights for policymakers, healthcare professionals, and the general public as we continue to navigate the evolving landscape of the pandemic.

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import os
for dirname, _, filenames in os.walk('/input'):
    for filename in filenames:
        print(os.path.join(dirname, filename))
```

```
/opt/conda/lib/python3.10/site-packages/scipy/__init__.py:146: UserWarning: A NumPy version >=1.16.5 and <1.23.0 is required for this version of SciPy (detected version 1.23.5
  warnings.warn(f"A NumPy version >={np_minversion} and <{np_maxversion}"
/input/covid-world-vaccination-progress/country_vaccinations_by_manufacturer.csv
/input/covid-world-vaccination-progress/country_vaccinations.csv
```

In [2]:

```
data = pd.read_csv("/input/covid-world-vaccination-progress/country_vaccinations.csv")
data.head()
```

Out[2]:

	country	iso_code	date	total_vaccinations	people_vaccinated	people_fully_vaccinated	daily_vaccinations_raw	daily_vaccinations	total_vaccinations_per_hundred	people_vaccinated_per_hundred	people_fully_vaccinated_per_hundred	daily_vaccinations_per_million	vaccines	source_name	source_website
0	Afghanistan	AFG	2021-02-22	0.0	0.0	NaN	NaN	NaN	0.0	0.0	NaN	NaN	Johnson&Johnson, Oxford/AstraZeneca, Pfizer/Bi...	World Health Organization	https://covid19.who.int/
1	Afghanistan	AFG	2021-02-2	NaN	NaN	NaN	NaN	1367.0	NaN	NaN	NaN	34.0	Johnson&Johnson, Oxford/AstraZeneca,	World Health Organizati	https://covid19.who.int/

	country	iso_code	date	total_vaccinations	people_vaccinated	people_fully_vaccinated	daily_vaccinations_raw	daily_vaccinations	total_vaccinations_per_hundred	people_vaccinated_per_hundred	people_fully_vaccinated_per_hundred	daily_vaccinations_per_million	vaccines	source_name	source_website
			3										Pfizer/Bi...	on	
2	Afghanistan	AFG	2021-02-24	NaN	NaN	NaN	NaN	1367.0	NaN	NaN	NaN	34.0	Johnson&Johnson, Oxford/AstraZeneca, Pfizer/Bi...	World Health Organization	https://covid19.who.int/
3	Afghanistan	AFG	2021-02-25	NaN	NaN	NaN	NaN	1367.0	NaN	NaN	NaN	34.0	Johnson&Johnson, Oxford/AstraZeneca, Pfizer/Bi...	World Health Organization	https://covid19.who.int/
4	Afghanistan	AFG	2021-02-2	NaN	NaN	NaN	NaN	1367.0	NaN	NaN	NaN	34.0	Johnson&Johnson, Oxford/AstraZeneca, Pfize	World Health Organizati	https://covid19.who.int/

	country	iso_code	date	total_vaccinations	people_vaccinated	people_fully_vaccinated	daily_vaccinations_raw	daily_vaccinations	total_vaccinations_per_hundred	people_vaccinated_per_hundred	people_fully_vaccinated_per_hundred	daily_vaccinations_per_million	vaccines	source_name	source_website
			6										r/Bi...	on	

In [3]:
```
data.describe()
```

Out[3]:

	total_vaccinations	people_vaccinated	people_fully_vaccinated	daily_vaccinations_raw	daily_vaccinations	total_vaccinations_per_hundred	people_vaccinated_per_hundred	people_fully_vaccinated_per_hundred	daily_vaccinations_per_million
count	4.360700e+04	4.129400e+04	3.880200e+04	3.536200e+04	8.621300e+04	43607.000000	41294.000000	38802.000000	86213.000000
mean	4.592964e+07	1.770508e+07	1.413830e+07	2.705996e+05	1.313055e+05	80.188543	40.927317	35.523243	3257.049157
std	2.246004e+08	7.078731e+07	5.713920e+07	1.212427e+06	7.682388e+05	67.913577	29.290759	28.376252	3934.312440
min	0.000000e+00	0.000000e+00	1.000000e+00	0.000000e+00	0.000000e+00	0.000000	0.000000	0.000000	0.000000
25%	5.264100e+05	3.494642e+05	2.439622e+05	4.668000e+03	9.000000e+02	16.050000	11.370000	7.020000	636.000000

	total_vaccinations	people_vaccinated	people_fully_vaccinated	daily_vaccinations_raw	daily_vaccinations	total_vaccinations_per_hundred	people_vaccinated_per_hundred	people_fully_vaccinated_per_hundred	daily_vaccinations_per_million
50%	3.590096e+06	2.187310e+06	1.722140e+06	2.530900e+04	7.343000e+03	67.520000	41.435000	31.750000	2050.000000
75%	1.701230e+07	9.152520e+06	7.559870e+06	1.234925e+05	4.409800e+04	132.735000	67.910000	62.080000	4682.000000
max	3.263129e+09	1.275541e+09	1.240777e+09	2.474100e+07	2.242429e+07	345.370000	124.760000	122.370000	117497.000000

In [4]:
```
pd.to_datetime(data.date)
data.country.value_counts()
```

Out[4]:
```
Norway                                482
Latvia                                480
Denmark                               476
United States                         471
Russia                                470
                                     ...
Bonaire Sint Eustatius and Saba       146
Tokelau                               114
Saint Helena                           92
Pitcairn                               85
Falkland Islands                       67
Name: country, Length: 223, dtype: int64
```

In [5]:
```
data = data[data.country.apply(lambda x: x not in ["England", "Scotland", "Wales", "Northern Ireland"])]
data.country.value_counts()
```

Out[5]:
```
Norway                                482
Latvia                                480
Denmark                               476
United States                         471
Canada                                470
                                     ...
Bonaire Sint Eustatius and Saba       146
Tokelau                               114
```

```
Saint Helena                          92
Pitcairn                              85
Falkland Islands                      67
Name: country, Length: 219, dtype: int64
```

In [6]:

```
data.vaccines.value_counts()
```

Out[6]:

```
Johnson&Johnson, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech
 7608
Oxford/AstraZeneca
 6022
Oxford/AstraZeneca, Pfizer/BioNTech
 4629
Moderna, Oxford/AstraZeneca, Pfizer/BioNTech
 4491
Johnson&Johnson, Moderna, Novavax, Oxford/AstraZeneca, Pfizer/BioNTech
 3564

 ...
Johnson&Johnson, Oxford/AstraZeneca, Sinovac
  312
Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac, Sputnik V
  311
Johnson&Johnson, Moderna
  251
Johnson&Johnson, Pfizer/BioNTech, Sinopharm/Beijing
  228
EpiVacCorona, Oxford/AstraZeneca, QazVac, Sinopharm/Beijing, Sputnik V, ZF2001
  190
Name: vaccines, Length: 84, dtype: int64
```

In [7]:

```
df = data[["vaccines", "country"]]
df.head()
```

Out[7]:

	vaccines	country
0	Johnson&Johnson, Oxford/AstraZeneca, Pfizer/Bi...	Afghanistan
1	Johnson&Johnson, Oxford/AstraZeneca, Pfizer/Bi...	Afghanistan
2	Johnson&Johnson, Oxford/AstraZeneca, Pfizer/Bi...	Afghanistan

	vaccines	country
3	Johnson&Johnson, Oxford/AstraZeneca, Pfizer/Bi...	Afghanistan
4	Johnson&Johnson, Oxford/AstraZeneca, Pfizer/Bi...	Afghanistan

In [8]:

```
dict_ = {}
for i in df.vaccines.unique():
  dict_[i] = [df["country"][j] for j in df[df["vaccines"]==i].index]
vaccines = {}
for key, value in dict_.items():
  vaccines[key] = set(value)
for i, j in vaccines.items():
  print(f"{i}:>>{j}")
```

```
Johnson&Johnson, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing:>>{'Camer
oon', 'Afghanistan', 'Belize', 'Namibia', 'Trinidad and Tobago'}
Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac, Sputnik V:>>{'Oman', 'Bosnia and He
rzegovina', 'Albania', 'Azerbaijan'}
Oxford/AstraZeneca, Sinopharm/Beijing, Sinovac, Sputnik V:>>{'Algeria', 'Zimbabwe
'}
Moderna, Oxford/AstraZeneca, Pfizer/BioNTech:>>{'Guernsey', 'United Kingdom', 'Fi
ji', 'Sweden', 'Australia', 'Jersey', 'Sint Maarten (Dutch part)', 'Finland', 'An
dorra', 'Japan', 'Isle of Man'}
Oxford/AstraZeneca:>>{'Montserrat', 'Kiribati', 'Saint Helena', 'Saint Vincent an
d the Grenadines', 'Liberia', 'Falkland Islands', 'Solomon Islands', 'Tuvalu', 'V
anuatu', 'Democratic Republic of Congo', 'Pitcairn', 'Mali', 'Papua New Guinea',
'Nigeria', 'Samoa', 'Nauru', 'Togo', 'Angola', 'Tonga', 'Sao Tome and Principe'}
Oxford/AstraZeneca, Pfizer/BioNTech:>>{'Anguilla', 'Saudi Arabia', 'Gibraltar', '
Saint Lucia', 'Cayman Islands', 'New Zealand', 'Saint Kitts and Nevis', 'Panama',
 'Bermuda', 'Costa Rica', 'Kosovo'}
Oxford/AstraZeneca, Pfizer/BioNTech, Sputnik V:>>{'Antigua and Barbuda'}
CanSino, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sputnik
 V:>>{'Argentina'}
Moderna, Oxford/AstraZeneca, Sinopharm/Beijing, Sinovac, Sputnik V:>>{'Armenia'}
Pfizer/BioNTech:>>{'Monaco', 'Tokelau', 'Cook Islands', 'New Caledonia', 'Turks a
nd Caicos Islands', 'Niue', 'Aruba'}
Johnson&Johnson, Moderna, Novavax, Oxford/AstraZeneca, Pfizer/BioNTech:>>{'Czechi
a', 'Slovenia', 'Netherlands', 'Germany', 'Austria', 'South Korea', 'Lithuania',
'Italy'}
Johnson&Johnson, Oxford/AstraZeneca, Pfizer/BioNTech:>>{'Bahamas', 'Eswatini', 'G
renada'}
Johnson&Johnson, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing,
 Sputnik Light, Sputnik V:>>{'Bahrain'}
Johnson&Johnson, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing,
 Sinovac:>>{'Bangladesh'}
```

Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing:>>{'Maldives', 'Peru', 'Suriname', 'Barbados', 'Dominica'}
Sinopharm/Beijing, Sputnik V:>>{'Belarus', 'Kyrgyzstan'}
Johnson&Johnson, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech:>>{'Cyprus', 'Portugal', 'Iceland', 'Malta', 'Belgium', 'Croatia', 'Jamaica', 'Luxembourg', 'Poland', 'France', 'Greece', 'Spain', 'Romania', 'Bulgaria', 'Estonia', 'Ireland', 'Canada'}
Johnson&Johnson, Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac:>>{'Benin', 'Brazil'}
Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing:>>{'Cape Verde', 'Bhutan'}
Johnson&Johnson, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sputnik V:>>{'Moldova', "Cote d'Ivoire", 'Morocco', 'Bolivia'}
Moderna, Pfizer/BioNTech:>>{'Faeroe Islands', 'Norway', 'Bonaire Sint Eustatius and Saba', 'Curacao', 'Qatar', 'Israel'}
Covaxin, Johnson&Johnson, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac:>>{'Botswana'}
Johnson&Johnson, Oxford/AstraZeneca:>>{'British Virgin Islands', 'South Sudan', 'Malawi'}
Johnson&Johnson, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing:>>{'Nepal', 'Brunei', 'Kenya', 'Kuwait'}
Johnson&Johnson, Oxford/AstraZeneca, Sinopharm/Beijing:>>{'Gambia', 'Mozambique', 'Madagascar', 'Senegal', 'Lesotho', 'Zambia', 'Burkina Faso'}
Sinopharm/Beijing:>>{'Equatorial Guinea', 'Burundi', 'Chad'}
Johnson&Johnson, Oxford/AstraZeneca, Sinopharm/Beijing, Sinovac:>>{'Somalia', 'Cambodia'}
Covaxin, Oxford/AstraZeneca:>>{'Central African Republic'}
CanSino, Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac:>>{'Chile', 'Ecuador'}
CanSino, Sinopharm/Beijing, Sinopharm/Wuhan, Sinovac, ZF2001:>>{'China'}
Johnson&Johnson, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac:>>{'Uganda', 'Ukraine', 'Colombia'}
Covaxin, Oxford/AstraZeneca, Sinopharm/Beijing:>>{'Mauritius', 'Comoros'}
Moderna, Oxford/AstraZeneca, Sinopharm/Beijing, Sputnik V:>>{'Congo'}
Abdala, Soberana Plus, Soberana02:>>{'Cuba'}
Johnson&Johnson, Moderna, Pfizer/BioNTech:>>{'United States', 'Liechtenstein', 'Denmark', 'Switzerland'}
Johnson&Johnson, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sinovac, Sputnik V:>>{'Egypt', 'Djibouti', 'Guinea'}
Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sinovac:>>{'Dominican Republic', 'Georgia', 'El Salvador'}
Covaxin, Johnson&Johnson, Oxford/AstraZeneca, Sinopharm/Beijing, Sinovac:>>{'Ethiopia'}
Johnson&Johnson, Pfizer/BioNTech:>>{'South Africa', 'French Polynesia'}
Pfizer/BioNTech, Sinopharm/Beijing, Sputnik V:>>{'Gabon'}
Oxford/AstraZeneca, Sputnik V:>>{'Ghana'}
Moderna:>>{'Greenland', 'Wallis and Futuna'}
Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sputnik V:>>{'Guatemala'}
Oxford/AstraZeneca, Sinopharm/Beijing:>>{'Niger', 'Myanmar', 'Mauritania', 'Sierra Leone', 'Guinea-Bissau'}
Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sputnik V:>>{'Sri Lanka', 'Guyana'}
Johnson&Johnson, Moderna:>>{'Haiti'}

Johnson&Johnson, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sputnik V:>>{'Hond
uras'}
Pfizer/BioNTech, Sinovac:>>{'Hong Kong'}
Johnson&Johnson, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing,
 Sputnik V:>>{'Hungary', 'Jordan'}
Covaxin, Oxford/AstraZeneca, Sputnik V:>>{'India'}
Johnson&Johnson, Moderna, Novavax, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm
/Beijing, Sinovac:>>{'Indonesia'}
COVIran Barekat, Covaxin, FAKHRAVAC, Oxford/AstraZeneca, Razi Cov Pars, Sinopharm
/Beijing, Soberana02, SpikoGen, Sputnik V:>>{'Iran'}
Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sputnik V:>>{'Lebanon', '
Iraq', 'Montenegro', 'Mongolia', 'Serbia'}
QazVac, Sinopharm/Beijing, Sputnik V:>>{'Kazakhstan'}
Johnson&Johnson, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sinovac,
 Sputnik Light, Sputnik V:>>{'Laos'}
Johnson&Johnson, Moderna, Novavax, Pfizer/BioNTech:>>{'Latvia'}
Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sinovac, Sputnik V:>>{'No
rth Macedonia', 'Libya'}
Pfizer/BioNTech, Sinopharm/Beijing:>>{'Macao'}
CanSino, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sinovac:>>{'Mala
ysia'}
CanSino, Johnson&Johnson, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac,
Sputnik V:>>{'Mexico'}
Abdala, Johnson&Johnson, Oxford/AstraZeneca, Pfizer/BioNTech, Soberana02, Sputnik
 Light, Sputnik V:>>{'Nicaragua'}
Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac:>>{'Northern Cyprus', 'Timor', 'Urug
uay'}
CanSino, Covaxin, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing,
 Sinovac, Sputnik V:>>{'Pakistan'}
Johnson&Johnson, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing,
 Sinovac, Sputnik Light, Sputnik V:>>{'Palestine', 'Philippines'}
Covaxin, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sinovac,
 Sputnik V:>>{'Paraguay'}
EpiVacCorona, Sputnik V:>>{'Russia'}
Johnson&Johnson, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing,
 Sinovac, Sputnik V:>>{'Tunisia', 'Rwanda'}
Pfizer/BioNTech, Sputnik V:>>{'San Marino'}
Oxford/AstraZeneca, Sinopharm/Beijing, Sputnik V:>>{'Seychelles'}
Moderna, Pfizer/BioNTech, Sinopharm/Beijing, Sinovac:>>{'Singapore'}
Johnson&Johnson, Moderna, Novavax, Oxford/AstraZeneca, Pfizer/BioNTech, Sputnik
V:>>{'Slovakia'}
Johnson&Johnson, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sinova
c:>>{'Sudan'}
Johnson&Johnson, Oxford/AstraZeneca, Sinopharm/Beijing, Sinovac, Sputnik Light, S
putnik V:>>{'Syria'}
Medigen, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech:>>{'Taiwan'}
Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac, Sputnik V:>>{'Tajikistan'}
Johnson&Johnson, Pfizer/BioNTech, Sinopharm/Beijing:>>{'Tanzania'}
Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sinovac:>>{'Thai
land'}
Pfizer/BioNTech, Sinovac, Turkovac:>>{'Turkey'}

```
EpiVacCorona, Oxford/AstraZeneca, QazVac, Sinopharm/Beijing, Sputnik V, ZF2001:>>
{'Turkmenistan'}
Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sinopharm/Wuhan, Sputnik
V:>>{'United Arab Emirates'}
Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac, Sputnik Light, Sputnik V,
ZF2001:>>{'Uzbekistan'}
Abdala, Sinopharm/Beijing, Sinovac, Soberana02, Sputnik Light, Sputnik V:>>{'Vene
zuela'}
Abdala, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sputnik
V:>>{'Vietnam'}
Johnson&Johnson, Oxford/AstraZeneca, Sinovac:>>{'Yemen'}
```

In [9]:

```
import plotly.express as px
import plotly.offline as py
vaccine_map = px.choropleth(data, locations = 'iso_code', color = 'vaccines')
vaccine_map.update_layout(height=300, margin={"r":0,"t":0,"l":0,"b":0})
vaccine_map.show()
```